

High Latitude Survey Cosmological constraints

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Overview

- Prospective constraints for
 - Weak lensing and galaxy positions from photometric survey
 - BAO and redshift space distortions from spectroscopic survey
 - Planck CMB temperature + E-mode polarization
- Two scenarios considered to understand BAO/lensing tradeoffs
 - Compared to EUCLID specifications
- Statistical and systematic error estimates
- Focusing on basic FoM measures
 - $w(a)=w_0+(1-a)w_a \Rightarrow$ mainly driven by distances/ expansion history
 - $\gamma \Rightarrow$ driven by growth of structure

Survey assumptions

- Consider 3 prospective surveys

	WFIRST deep	WFIRST deep+wide		EUCLID
		deep	wide	
survey	WL+BAO/rsd	WL+BAO/rsd	BAO/rsd only	WL+BAO/rsd
survey duration (yr)	2	1	1	> 5
survey area (sq. deg.)	5280	2640	11000	20000
wl galaxies/ sq. arcmin	30	30	-	30
bao/rsd galaxies/ Mpc^3	from Chris H's exposure time calc		Geach et. al.	

- Two WFIRST scenarios to assess trade offs between BAO preference for survey area against WL repeat imaging
 - 2 year deep survey benefits lensing
 - 1 year deep + 1 year wide benefits BAO/RSD

Photometric survey assumptions

- Statistical uncertainties taken as similar for each survey

	Common across surveys
N_{ph} photo-z bins	10
z range	$0.1 < z < 2$
photo-z error $/(1+z)$	0.04
rms. shear dispersion	0.25

- Systematic uncertainties guided by CH's in FoMSWG

	1σ prior	Independent Gaussian to:
photo-z offset/ $(1+z)$	0.002	N_{ph} z-bins
G magnification bias	$0.001N_{ph}$	N_{ph} lensing bins
IA GI amplitude	$0.003\sqrt{N_{grid}}$	$N_{grid} = 25$ bias bins $b_{IRI}(k, z)$

Figures of merit : used

- We are using the commonly quoted FoM for the initial study
- DETF FoM for w
 - $w(a) = w_0 + (1-a)w_a$, minimum error on w at a_p , $w_p = w(a_p)$
$$FoM(w) = \frac{1}{\sigma(w_a)\sigma(w_p)}$$
 - Pros:
 - Simple, widely used extension of constant w ,
 - Easily extendible to $z \sim 1100$ for CMB
 - Cons relevant to WFIRST:
 - Inadequately reflects uncertainties in $w(z)$ at $z > 1$
- γ parameter for growth history
 - Assume $\gamma = \gamma_{GR} + \Delta\gamma$ at $z < 3$
$$FoM(\gamma) = \sigma(\Delta\gamma)$$
 - Pros:
 - Simple, single parameter, with clearly defined value in Λ CDM/GR.
 - Cons relevant to WFIRST:
 - Doesn't assess ability to distinguish differences in how gravity affects relativistic (lensing) and non-relativistic (RSD) tracers of geodesics

Figures of merit : alternatives

- Alternative figures of merit could highlight WFIRST's strengths more effectively

- FoM for w: $X(z) = \rho_{DE}(z)/\rho_{DE}(0)$ at discrete z

$$FoM(X_i) = \frac{1}{\sqrt{\det[Cov(\{X_i\})]}}$$

- More effectively shows constraining power at $z > 1$

- FoM for growth: $G_{eff} = QG$ and $\Psi/\Phi = R$

$$FoM(Q, R) = \frac{1}{\sqrt{\det[Cov(Q, R)]}}$$

- Measures second property of potential modification to GR, $R \neq 1$

- But both improvements come at the cost of additional complexity

Constraining w, assuming GR

tag	Data	scenario	$[\sigma(w_a)\sigma(w_p)]^{-1}$	a_p	$\sigma(w_0)$	$\sigma(w_a)$	$\sigma(w_p)$
1	cmb+wl	deep+wide	5.	0.56	0.620	1.377	0.143
2	cmb+wl	deep	7.	0.56	0.474	1.032	0.141
3	cmb+wl	Euclid	52.	0.58	0.181	0.412	0.046
4	bao/rsd	deep+wide	176.	0.75	0.070	0.263	0.022
5	bao/rsd	deep	143.	0.75	0.078	0.295	0.024
6	bao/rsd	Euclid	211.	0.78	0.053	0.222	0.021
7	cmb+wl+bao/rsd	deep+wide	1125.	0.75	0.021	0.063	0.014
8	cmb+wl+bao/rsd	deep	954.	0.75	0.023	0.068	0.015
9	cmb+wl+bao/rsd	Euclid	1416.	0.76	0.019	0.059	0.012
10	cmb+wl+bao/rsd	3y deep+2y wide	2331.	0.80	0.013	0.053	0.008

deep = 2 year, 5280 sq.deg. wl+bao/rsd surveys concurrently

deep+wide = 1 year, 2640 sq.deg. wl+bao/rsd &, 1 year, 11,000 sq.deg. spectroscopic survey

Euclid = 5 year 20,000 sq.deg. wl+bao/rsd survey

3 yr deep + 2 yr wide = 3 year, 7920 sq.deg. wl+bao/rsd &, 2 year, 22,000 sq.deg. spectroscopic survey

cmb = Planck T + E data

wl = shear-shear correlations

bao/rsd = BAO and peculiar velocity correlations

Constraining gravity: w and γ

tag	Data	scenario	$[\sigma(w_a)\sigma(w_p)]^{-1}$	a_p	$\sigma(w_0)$	$\sigma(w_a)$	$\sigma(w_p)$	$\sigma(\Delta\gamma)$
1	cmb+wl	deep+wide	5.	0.56	0.621	1.380	0.143	0.123
2	cmb+wl	deep	7.	0.56	0.477	1.038	0.141	0.115
3	cmb+wl	Euclid	50.	0.57	0.182	0.413	0.048	0.070
4	bao/rsd	deep+wide	86.	0.70	0.095	0.286	0.041	0.072
5	bao/rsd	deep	69.	0.70	0.107	0.320	0.045	0.081
6	bao/rsd	Euclid	120.	0.73	0.075	0.248	0.034	0.048
7	cmb+wl+bao/rsd	deep+wide	712.	0.74	0.027	0.063	0.022	0.033
8	cmb+wl+bao/rsd	deep	619.	0.77	0.028	0.068	0.024	0.035
9	cmb+wl+bao/rsd	Euclid	931.	0.68	0.027	0.065	0.017	0.022
10	cmb+wl+bao/rsd	3y deep+2y wide	1059.	0.72	0.023	0.057	0.017	0.027

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EXTRA SLIDES

Cosmological model

- WMAP 5 FOMSWG cosmology

Parameter	Value
$\Omega_b h^2$	0.0227
$\Omega_c h^2$	0.1099
Ω_X	0.7435
Ω_K	0
τ	0.0856
w_0	-1
w_a	0
$\Delta\gamma$	0
n_s	0.963
$\Delta_{\mathcal{R}}^2(k = 0.05/Mpc)$	2.139×10^{-9}
H_0	71.9
σ_8	0.793